Lendenfeld, while travelling through the wooded parts of Australia for days and days, did not observe a single blade of grass. The soil, which consisted to a great extent of red clay, was smooth as asphalt pavement, and hard as rock. Rain, when falling on such soil, does not penetrate it, but runs off rapidly. The low-lying regions are inundated; but it appears that the water is not evaporated there, but flows through subterranean channels into the ocean. There are no rivers with large watersheds in Australia. Even the largest river, the Murray, is navigable only in winter and for light steamboats.

The water runs off so quickly that it has hardly time to penetrate the hard and smooth ground. The woods, therefore, do not increase the humidity of the soil and of the air.

In many places the squatters begin to cut down the trees, so far as the laws permit their doing so. The local effect is marvellous. Lendenfeld observed that so many kinds of grasses began to grow, that on the same space on which, before the cutting-down of the trees, only one hundred sheep could be raised, a thousand found sufficient food.

This effect is brought about in the following way. As the trees do not absorb the humidity of the deep layers of the ground, it reaches the surface and is absorbed by the grasses. The decaying stems of the grasses form small channels in the soil, which lead to larger ones that were formerly occupied by the roots of the trees. Thus the ground becomes permeable for water. When rain falls, it runs off slowly, as the grasses hinder its movements. It penetrates the ground, and thus a greater portion of the total amount of rainfall benefits the spot at which it falls. Part of it evaporates, and thus increases the humidity of the air.

It has been said that the springs become more numerous by the cutting-down of the woods, as the grasses do not use the humidity of the deeper layers of the ground. Lendenfeld, however, maintains that the increase of water carried by the springs is not as great as the increase of water retained in the soil through the action of the grasses, and that a great part of the water of springs is evaporated, and increases the humidity of the air.

From all these facts, Lendenfeld concludes that in Australia the effect of deforesting the country is not a decrease, but an increase, of rainfall.

NEW ZEALAND LETTER.

THE long-continued commercial depression under which this colony still labors affects every class of the community, and is working a quiet, but in some respects much-needed, revolution in the habits of the people. There is no doubt that the colonists in former years had no ideas of economy in any direction; but these are now being forced on their notice in all sorts of ways. Early in last session of the Colonial Parliament, the Stout-Vogel ministry was overthrown, and Major (now Sir Harry) Atkinson assumed the reins of office, under strict pledges to enforce retrenchment in every possible direction. As far as the public can judge, these pledges are being fulfilled fearlessly and without favor.

In matters educational the primary-school system and the University of New Zealand come directly upon government for assistance. The former is altogether, and the latter to a considerable extent, dependent upon the annual appropriations made by the legislature. Considerable reductions have been made in the amount allotted for primary schools; but, as is so often the case, these reductions have not been effected in perhaps the best directions. Thus it was considered advisable to contract the school age at one or both ends. At present it commences at five years of age, and it was proposed to raise it to six. This would have disposed of the charge so often brought against the infant classes, especially of country schools, that they are merely convenient nursing-depots, where the younger children of a family are kept warm and out of mischief for a great part of each day. But the House of Representatives, in their wisdom, saw fit to retain the school age at five, but to knock off the highest or seventh standard. In times of depression, when it is difficult to find occupation for either old or young, it is commonly noticed that boys who have completed their sixth standard work are sent adrift to loaf on their parents, who cannot get them any work to do. For such a class alone, it would have been economy to keep the upper standards open, even had a small fee been charged. No education is so bad as that of the streets and of enforced idleness.

Another possible and profitable source of retrenchment in this much-overgoverned community would have been the abolition of some of the smaller education boards. It seems absurd, that, with a small population of some six hundred thousand, there should be something like twelve education boards, each with its paid staff of officials, — secretary, inspectors, etc. The abolition of at least six of these would have made a substantial reduction in the education vote: but, as it would have weakened or endangered the position of many of our precious representatives, it was not even considered, but, instead, the training-colleges at Auckland and Wellington were abolished; so that no adequate provision now exists in the North Island for the education of teachers. The free, secular, and compulsory system of primary education of this colony is one of the things the community is proud of, but it is a decidedly retrograde step when provision for adequately training its teachers is not made.

Secondary school education is all carried on in specially endowed schools, governed mainly by separate boards, and practically independent of the education department. Private enterprise in this direction is so handicapped by the endowments, that, except in a few cases of very special class schools, there are no private schools in the colony. A determined effort is made by a certain section of politicians to capitalize all these endowments for the benefit of the colony, and especially of primary education, and thus make secondary education dependent upon the support it might receive from those classes most able to provide it. Such a measure, if carried into effect, would close the avenues of the higher education to the poorer classes; while at present, owing to the low fees charged at the high schools (averaging from $50 to $62.50 per annum), and to the liberal provision made for scholarships, every boy or girl of promise in the primary school has a good chance of continuing his or her education in higher subjects at the public expense. While the secondary schools have not, in most cases, been retrenched directly, yet, as the revenues from their endowments have in nearly every case fallen considerably, the salaries of all their teachers have had to be correspondingly reduced.

The teaching of science occupies a very fair place in the curricula of New Zealand schools. In the primary schools very little is attempted beyond a few lessons in physics, physiology, or chemistry in the higher classes of the better schools. But alongside of this, rather heavy demands are made upon teachers going up for their examinations. Indeed, some knowledge of so many science subjects is demanded of them, that this part of the examination for classification defeats its own object. Were each teacher permitted to select one or two branches of science, and were they expected to attain a fairly high standard of efficiency in it, the introduction of really good science-teaching in the schools would soon follow, and indeed could be demanded.

In the secondary schools, provision of a kind is usually made for teaching one or two branches, although in only two schools in the colony is there a science-teacher who is a specialist. In most cases one of the staff is selected for his knowledge of some scientific subject; while the head master, being nearly always a classical scholar, does not, as a rule, attach a very high value to this department of school-work. This, however, is counterbalanced to a great extent by the importance which the New Zealand University attaches to science in its junior scholarship examinations, whose requirements constitute in many cases the guiding lines of the curricula of the high schools. For example: at the examination held last December, out of 60 candidates, 12 offered in botany, 26 in chemistry, 11 in mechanics, 14 in heat, 6 in electricity, and 1 in sound and light; that is to say, that, as each candidate who took science had to select any two subjects, 35 had offered themselves in this section of the examination. Most of the schools have either a small laboratory or at least a small stock of materials for teaching chemistry and some elementary physics, but little or none for the more specialized branches of the latter.

It is difficult for one not acquainted with the actual standards attempted, and the results gained, in schools of other countries, to compare the work done in our educational establishments with that done elsewhere. At the same time it is a fact that the medi-

cal students, who, after taking the early part of their training in the colonial high schools and colleges, proceed to Edinburgh to complete their course, invariably give a very good account of themselves.

In matters of purely scientific interest there is but little to chronicle at present from the colony. The want of money seems to have paralyzed even much of the available energy of the colonists; many men who formerly thought themselves in possession of a competency for the rest of their lives, being under the necessity again of commencing the grim battle for bread. It must be borne in mind that there is practically no cultured class in the colony, outside of those who are compelled to work. The scientific research and work which have been put forth from these islands have been done usually in the course of, or in the intervals of, hard professional work, by settlers, surveyors, medical men, lawyers, and teachers. There is only one purely scientific association for the whole colony, — the New Zealand Institute; formed, however, of a number of affiliated societies, each having its own rules, office-bearers, funds, etc. The chief of these are the Auckland Institute, the Wellington Philosophical Society, the Philosophical Institute of Canterbury (meeting in Christchurch), and the Otago Institute (meeting in Dunedin). Besides these, there are smaller branches at Napier, Nelson, Hokitika, and Invercargill. The central body, termed the New Zealand Institute, is practically only an administrative board, partly elected by the affiliated societies, but chiefly nominated by the governor. This body is charged with the publication of the papers on scientific matters, which are read before the various affiliated societies; and these constitute a bulky octavo volume, containing last year nearly seven hundred pages. The management of the whole is in the hands of Sir James Hector, director of the Geological Survey, who indeed has been the central figure of the institute since its establishment in 1867. A government grant of £500 per annum meets the chief cost of publishing the annual volume of Transactions and Proceedings, but this is occasionally supplemented by small levies on the affiliated bodies. The total number of members of the various branches of the institute is about 1,250, — a most creditable number, when the population of the colony is considered, and when it is borne in mind that each of these is a voluntary member and subscriber to the extent of at least a guinea a year. The pages of the nineteen volumes of Transactions teem with valuable papers on many branches of natural science, zoölogy and botany having the largest number of votaries. The isolated position of the colony makes the study of its groups of plants and animals peculiarly complete from the point of view of geographical distribution. Hence many European specialists have devoted some of their time to working out all the New Zealand forms of one or other group. Thus at present Baron Osten-Sacken is engaged on the *Diptera*, — a group regarding which very little is known in the colony, but the members of which take a large share in the fertilization of its flowering plants. Mr. E. Meyrick has systematically studied many groups of the *Micro-lepidoptera*, and is still engaged on others. The New Zealand *Araneæ* were formerly only known from the Rev. O. Pickard-Cambridge's papers, in the London Zoölogical Society's Transactions. Now, however, they are being taken up by Messrs. Urquhart of Auckland, and Goyen of Dunedin, both of whom are doing very good work. At present, as has mostly been the case in the past, the chief work done in the colony has been systematic; and even this has been done under great difficulties, the principal one being the impossibility of consulting all the literature of any subject.

Some two years ago the Royal Society of England made a grant to Prof. T. J. Parker of Dunedin to aid him in working out the embryology of the Tuatera lizard (*Sphenodon*), and also of the Kiwi (*Apteryx*). Living specimens of the former were obtained and kept in confinement both by Professor Parker and by Professor Thomas of Auckland, but up to the present time no eggs have been laid. But the study of the embryological development of *Apteryx* has been prosecuted much more successfully, and zoölogists may shortly expect a communication on the subject to the Royal Society, which will contain many points of interest.

Matters geological, especially those relating to mining, bulk much more largely in people's minds here than any other questions of a scientific kind. It is felt that New Zealand must look in the future more to her mineral wealth for her prosperity than ever she has done in the past, and it is in this quarter that most of the available capital is being directed — or, one might say, misdirected. A great amount of money is sunk in unscientific ways of mining and of prospecting. The country teems with mineral wealth, but it wants more knowledge, and less blind working. Very many of the mining ventures have turned out, as indeed is the case everywhere, unsatisfactorily. Copper-mines have been opened in various parts, but none are now in operation. Antimony occurs abundantly, but has never been profitably worked. The enormous deposits of iron-sand on our sea-beaches are still practically unworked. An attempt is being made to work the oil-bearing beds of the east coast of the North Island, but it is impossible to see how the projectors can successfully compete against the cheap oils of Pennsylvania. The one great stand-by of the colony is gold, and the crying want of the miners is some method of saving the fine gold which at present is lost. When it is seen that the 'tailings' of the famous Blue Spur diggings, which have been washed over several times, are still being sluiced by Chinamen who are making from two dollars to three dollars a day, it is clear that the art of gold-saving is still in its infancy.

Within the last few months a number of Wellman's dredges have been constructed to attack the beaches of auriferous sand and the river-beds. As these come into use, the quantity of gold obtained will be increased, and the available extent of field much enlarged.

G. M. T.

Dunedin, Feb. 23.

GRÜNWALD'S THEORY OF SPECTRUM ANALYSIS.

THERE has lately been advanced by Professor Grünwald of Prague a theory of the change which the spectrum of a substance undergoes when that substance enters into combination with another, that is so extremely simple that it is difficult to see how it can possibly be true. But the number and exactness of the coincidences that Professor Grünwald has observed are such as to arrest attention, and give some interest to the theory which is based on them.

The discoverer states, that, by a mathematical investigation of the changes which the spectra of two gases undergo when brought into chemical combination, he has been able to establish a law, as simple as it is important, which may be the basis of a future mathematico-chemical analysis; and by the aid of this law he has been able not only to establish a very remarkable relation between the spectra of hydrogen and oxygen on the one hand, and that of water-vapor on the other, but also to discover the chemical composition and structure of hydrogen and oxygen, and bring out the facts of the dissociation of hydrogen in the atmosphere of the sun.

The fundamental theorem of this new mode of analysis is as follows. Suppose we have a chemical element a, which, when combined with some other elements, forms a gaseous substance A. When the gas A unites with some other substance, a chemical compound B is formed, in which the element a is also contained, but in a different condition from that in which it existed in A. Usually the atomic volume of the substance a, reckoned in the ordinary way in use among chemists, will be different in the last case from what it was in the first, and the ratio of the atomic volumes in the two cases will be expressed as a ratio of two simple whole numbers. The above being granted, the theorem asserts that those wave-lengths of light in the spectrum of the substance A that belong to the element a are to the wave-lengths due to that element in the spectrum of the substance B in the same ratio as the atomic volume of a in A is to its atomic volume in B.

It follows from the above, that, when the atomic volume is unchanged by the combination, the wave-lengths of the lines due to the substance will be the same in both cases. But great variation between the spectra may exist notwithstanding, because, as Professor Grünwald remarks, the amplitudes of some of its modes of vibration may well be very different in the one case from what they are in the other. This, of course, means that the intensities of lines may be so different in the two cases that stray lines in the one spectrum may be so faint as to seem entirely lacking in the other. Thus, when hydrogen combines with chlorine, bromine, or iodine, the resulting gases, $H\,Cl$, $H\,Br$, and $H\,I$, are formed without change